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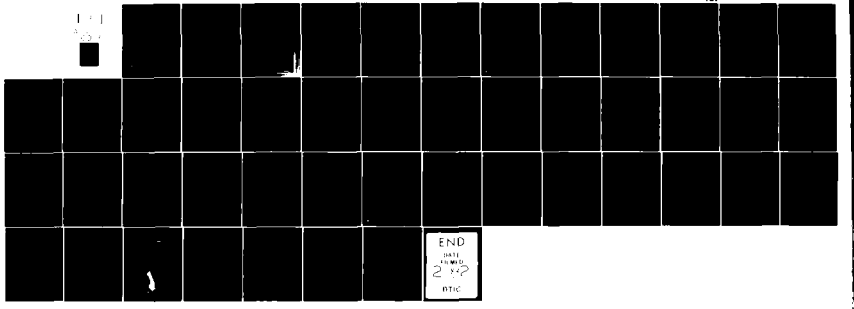

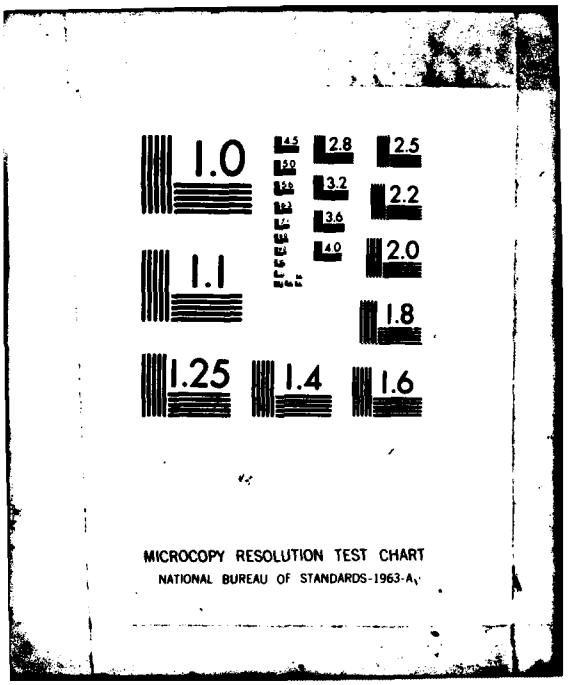
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FRANCIS E. WALTER DAM AND RESERVOIR PROJECT

WATER QUALITY DATA REPORT (RCS-DAEN-CWE-15)

Prepared by

U. S. Army Corps of Engineers
Philadelphia District
NAPEN-E

FOR THE PERIOD
OCTOBER 1, 1980 TO SEPTEMBER 30, 1981

REPORT NO: DAEN/NAP - 73825/WQDR81 - 81/12

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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Francis E. Walter Dam, Pa.
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This purpose of this report is to present and briefly interpret the water quality data collected to date in relation to the operation and control of Francis E. Walter Dam and Reservoir which is located at the convergence of Bear Creek and Lehigh River in Luzerne, Carbon and Monroe Counties in Northeast Pennsylvania. Included in the report itself are general characteristics of the area influenced by the dam, the project itself and the basin area draining into the lake.

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A description of the geological history, topography, soil description, vegetation and land use is presented within the report.

The water sampling data collected during calendar year 1981 indicated that the water quality in Francis E. Walter Lake remains within the standards established by Pennsylvania (DER) and U.S. Environmental Protection Agency. Results for the parameters such as dissolved oxygen, phosphorous, total dissolved solids, conductance, ammonia, nitrate and nitrite have remained fairly uniform and are within allowable limites for the water samples collected and analyzed during the testing period.

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1-01. Summary. The Francis E. Walter Dam and Reservoir is located at the convergence of Bear Creek and Lehigh River in Luzerne, Carbon and Monroe Counties in Northeast Pennsylvania. The project was completed in 1961. The drainage basin above the dam has not been greatly developed; however, the recent developments such as the Jack Frost Ski area and a shopping center at Blakeslee's corner has increased the potential for pollution to the impoundment.

The Francis Walter Lake is an oligotrophic lake having few nutrients and little plant life. Furthermore, due to the seasonal fluctuating water levels, trees and plant life have been destroyed within the flooding zone. The Philadelphia District's water quality monitoring program and supportive data has demonstrated that the reservoir is of very good water quality. (Appendix A)

The lake is operated as a flood control project with incidental recreation therein and, at times, for recreational white water canoe flow augmentation purposes downstream. The lake is appropriate for fishing, but the pressures exerted far outstrip the fish stocked or indigeneous therein.

Continued monitoring at present levels is a minimum to allow proper future management decisions and adjustments to the monitoring and management effort. The greatest problem to date has been a simple absence of data, which we are correcting through an on-going program. Cursory evaluations to date, aesthetics and considerable popular use of the lake corroborate that it is a valuable resource.

SECTION II - INFORMATION

2-01. Purpose and Scope. The purpose of this report is to present and briefly interpret the water quality data collected to date in relation to the operation and control of the F. E. Walter Dam and Reservoir. Included in the report are the general characteristics of the area influenced by the dam, the project itself, and the basin area draining into the lake. The information in this report will be useful for water quality management purposes. It should show relationships between water quality problems and effects of the lake on the water quality and serve as a source of reservoir data. It will also be useful in the planning and design of other projects.

2-02. Authority. This report is submitted in accordance with the Corps of Engineers' policy as authorized in ER 1110-2-334, "Water Quality Management at Corps Civil Works Facilities," 1 May 1974.

2-03. Background Information. Francis E. Walter Dam and Reservoir is located at the convergence of Bear Creek and Lehigh River in Luzerne, Carbon and Monroe Counties in Northern Pennsylvania. The reservoir is 86 miles north of Philadelphia, 20 miles southeast of Wilkes Barre, 39 miles south of Scranton, and 23 miles north of Allentown. The project area is part of the Pocono Mountain region which contains private and public recreation resorts serving primarily the residents of Pennsylvania, New York, and New Jersey. The project is accessible to the public by means of the Northeast Extension of Pennsylvania Turnpike, Interstate Routes 80 and 81, and Pennsylvania Routes 940 and 115. The general location is shown on Plate 1.

Project Structures and Data

a. Dam and Outlet Works

1. Drainage Areas

Total Lehigh River Basin	1,370 square miles
Above Bethlehem	1,279 square miles
Above Dam	288 square miles

Percentages of basin controlled by dam	21%
Percentage of basin above Bethlehem controlled by dam	23%

2. Embankment

Type	Earth fill with impervious compacted earth core; riprap cover
Top elevation, above sea level datum	1,474 ft.
Height above river bed	234 ft.
Top length	3,000 ft.
Top width	30 ft.
Freeboard above spillway design flood	5.4 ft.

3. Spillway

Type	Concrete ogee overflow section
Location	At northwest end of dam; right bank
Crest elevation	1,450 ft., s.l.d. 450 ft.
Type of channel	Improved natural water course
Total channel length	4,200 ft.

4. Reservoir

At spillway crest level (1,450 ft.):

Surface area	1,840 acres
Greatest length	8.1 miles (along Lehigh River)
Greatest width	4,000 ft.
Total capacity	111,000 acre-ft. (7.16 in. runoff)
Flood control capacity	108,000 acre-ft. (7.03 ion. runoff)

Probability of filling to spillway crest	2% chance in any one year
Emptying time from pool elevation 1,450 ft. to 1,300 ft., outflow limited to 10,000 c.f.s. assumed inflow at 1,000 c.f.s.	10 days
At conservation pool level (1,300 ft.):	
Surface area	90 acres
Greatest length	8,900 ft. (along Lehigh River)
Greatest width	1,200 ft.
Capacity-conservation	2,000 acre-ft. (0.13 in. runoff)
Reservoir shoreline	5 miles. Low flood plain to marsh to wooded hills and vertical rock cliffs.

5. Outlet Works

Type	Gate controlled, concrete lined tunnel
Si e of conduit	16 ft. diameter, circular
Inert elevation at intake	1,250 ft., s.l.d.
Inert elevation st exit portal	1,238 ft., s.l.d.
Length of conduit (including transitions)	1,150.5 ft.
Control gates	3 sets of 2-5'8" x 10'0" hydraulically operated vertical slide gates

Gate Operation

Maximum allowable flood control release	10,000 c.f.s.
Potential discharge through three opengates, pool at spillway crest	17,000 c.f.s. (approx.)
Rate of gate movement	0.8 ft./minute (approx.)
Time required, one gate, full open tofull closed, or clos d to full ' en	12-1/2 minutes (approx.)

Bypass System

Number	2
Si e of conduits	24" dia. cast iron pipe
Operation	One electrically operated 24" gate valve in each conduit
Intake weirs, elevation	1,297 ft., s.l.d.
Discharge capacity of system (2 units) with reservoir pool at elevation 1,301.	

2-04. Pertinent References. The following references are pertinent to this report, (ER 1110-2-1402 and 1130-2-415).

a. Water Quality/Bacteriological Data - Contract DACW61-79-D-0013. Appendix A.

b. Stratification Testing, Philadelphia District. Appendix B. (Not reproduced) Available in NAPEN-E files.

SECTION III - AREA AND PROJECT DESCRIPTION

3-01. River Basin Characteristics. The reservoir drainage area and dam site lie entirely within the Pocono Plateau physiographic province. The Pocono Plateau is well dissected, giving a mountainous appearance which is accentuated by the crooked, narrow, steep-wall valleys containin the Lehigh river and its upper major tributaries. In the vicinity of the reservoir site the surface elevations range from about 1,240 feet elevation in the river valley bottom to over 2,000 feet on the plateau proper.

Project lands are predominantly forested except for area cleared to accomodate project structures and access roads. The lands immediately adjacent to the project are undeveloped, similarly forested, and used only by hunters and occasional hikers.

That general condition has resulted in continuity of natural ecosystems in a virtually undisturbed state in a wide belt surroundings the project. Recreational use of project lands compliments that condition by limited and concentrated development sited mostly in the forest-cleared interface or in open space. The high mountain area which is almost totally forested is of great scenic interest and oriented as a summer recreational and winter sports region.

3-02. Project Description. The Francis E. Walter Dam projectt, completed in 1961, provides for flood storage, incidental recreation and at times, for recreational white water canoe flow augmentation downstream of the dam. The dam is located below the convergence of Bear Creek and Lehigh River in Luzerne, Carbon and Monroe counties. The water, at conservation pool level (1,300 ft.) has a surface area of 9000 acres and is 8,900 feet in length along the Lehigh River. The reservoir shoreline is approximately five miles in length and irregular in shape, one drainage area being the Lehigh River and the other Bear Creek. The shoreline is bounded by wooded hils and vertical rock cliffs limiting accessibility to some areas for fisherman except by the use of boats.

3-03. Climate. 1/ The Lehigh River Basin enjoys a temporate northeast Atlantic Coast climate that is characterized by frequent small changes in temperatures, ranging from -7°F to 88°F, and relatively frequent but moderate amounts of precipitation totalling 43 inches annually. A more detailed discussion on the climate of the area can be found in Appendix B, DM No. 10A. Selected climatological data for 1980-81 is found in Table 1.

1/ Climatological Data - 1980/81 - Walter Dam Project.

3-04. Dam and Lake Characteristics.

a. Embankment. The dam is a rock faced earth embankment with an impervious compacted earth core and random outer sections, has a crest length of 3,000 feet with a maximum height of 234 feet above river bed. The top of the dam is at elevation 1,474 feet (sea level datum). The top of the dam has a width of 30 feet and is surfaced with gravel to serve as a maintenance road. Access to the intake tower is by a service bridge.

b. Spillway. The spillway contains a concrete ogee overflow section which is located at the northwest wnd of the dam, right bank. The crest length is 450 feet at elevation 1,450 feet, s.l.d. The spillway discharge after leaving the improved natural water course will flow directly into the Lehigh River.

c. Outlet Works. The outlet works is located near the center of the dam and consists of a control tower and intake structure at invert elevation 1,250 feet, s.l.d., located on the upstream side of the dam and a conventional stilling basin is provided at the downstream end to dissipate the energy of the conduit.

d. Access Roads to Dam. Access to the top of the dam is from the government road near the spillway up an inclined driveway on the right bank of the impoundment.

e. Reservoir. The reservoir when filled to the top of the conservation pool, elevation 1,300, is approximately 8,900 feet long (along the Lehigh River) and 1,200 feet at point of maximum width. The average depth of the reservoir is about 25 feet and the maximum is 50 feet. The lands bordering the existing impoundment are characterized by many steep, rocky slopes and nearly vertical rock walls.

Project lands are forested except areas that were cleared for project implementation. Adjacent lands are similarly forested and undeveloped except along principal highways where seasonal homes and recreational complexes are found. Recreational facilities provided at the project consist of picnicking, fishing boat launching, hunting, sightseeing and hiking trails. The scenic and rugged beauty of the area is a prime moving factor for a general increase in attendance at Walter Dam over the past few years.

3-05. Geological History. The general geology and topography of the Lehigh River Basin in which Francis E. Walter Dam is located have been described in detail in Appendix B, DM No. 10A. The reservoir drainage area and the dam site lie entirely within the Pocono Plateau which is small, southeast trending lobe of the Appalachian Plateau physiographic province. The Pocono Plateau is well dissected, giving a mountainous appearance which is accentuated by the crooked, narrow steep-walled valleys containing the Lehigh River and its upper major tributaries. In the vicinity of the reservoir iste the surface elevations range from about 1,240 in the river valley bottom to over 2,000 on the plateau proper.

Two or more glaciers passed over the region, the results of the last being well preserved. The glacial action planed the area into broad expanses of thinly covered striated sandstone bedrock. During the melting of the last glacier an outwash deposit of boulders, gravel and sand filled the river valley in the reservoir area and at the dam site to a depth of more than 100 feet. Postglacial stream flow has removed much of this glacial outwash leaving as remnants terraces on the steep valley slopes. The Pocono Plateau is composed of gently undulating sandstones and shales belonging to the Catskill continental series of the Devonian system.

At the dam site the bedrock is an extremely hard silica-cemented gray sandstone and conglomerate containing quart pebbles up to one inch diameter, with occasional thin beds of gray to black shale. The thick to massive bedded sandstone and conglomerate have a rectangularly arranged joint pattern which is normal for flat-lying rock.

3-06. Topography. The lands bordering the existing impoundment are characteri ed by many steep, rocky slopes and nearly vertical rock walls. The west bank of the impoundment contains rock walls up to 100 feet high from the dam upstream into Bear Creek for a distance of about 400 feet. The east bank contains steep rocky slopes from the access road upstream for about 1,000 feet, a multi-level borrow area for the next 1,000 feet to the confluence of the Lehigh River. The bank becomes a nearly vertical rock wall at the 1,3000 foot elevation on the south side of the Lehigh River.

3-07. Soils Description. The soils of both Carbon County and Lu erne County have been exhaustively studied and catalogued by the U. S. Soil Conservation Service in cooperation with Pennsylvania State University and the Pennsylvania Department of Agriculture. The soils at the projects are well drained to moderately well drained. Refer to project master plan for a further discussion.

Soils are:

(a) Arnot Series. The Arnot soils are shallow, well drained upland soils formed in glacial till derived from acid sandstone, siltstone and some shale. They have a rocky silt loam surface layer and a thin channery silt loam subsoil. Sandstone bedrock ocurs at above 17 inches.

(b) Barbour Series. The Barbour soils consist of deep, well drained soils on flood plains formed from reddish colored stream deposits. They have a silt loam surface texture and a silt loam or sandy loam subsoil which is stratified in the lower part with sand and gravel.

(c) Bath Series. The Bath series consist of deep, well drained upland soils formed in glacial till derived from acid sandstone and shale. They have a channery silt loam to a very stony silt loam surface layer and a channery loam subsoil. A slowly permeable fragipan occurs at about 29 inches.

(d) Chenango Series. Chenango soils consist of deep, well drained to somewhat excessively drained soils of stream terraces and kames derived from gravelly outwash material. They have a gravelly loam surface layer, a very gravelly loam or very gravelly sandy loam subsoil and a stratified sand and gravel substratum.

(e) Dekalb Series. The Dekalb series consist mainly of stony steep mountainous soils that have formed in shallow to moderately deep forest-worked material. The series is moderately deep and well drained on uplands formed from sandstone. Sandstone bedrock occurs at about 34 inches.

(f) Lackawanna Series. The deep, well drained soils of the Lackawanna are found on uplands formed from reddish glacial till. They have a very stony silt loam surface layer and a channery loam subsoil. A slowly permeable fragipan occurs at about 26 inches.

(g) Leck Kill Series. The Leck Kill series consist of moderately deep, well drained, medium-textures soils that have a dark reddish-brown to black surface layer and a brown to reddish-brown subsoil. The soils have formed from a mixture of reddish-brown siltstone, shale and fine sandstone that has been reworked by glaciers. The bedrock underlying this material is mostly reddish-brown, but in places it is weak red or dark red.

(h) Mardin Series. The Mardin series are deep, moderately well drained soils on uplands formed from glacial till containing sandstone. They have a channery silt loam surface layer and a channery loam subsoil. A slowly permeable fragipan occurs at about 15 inches.

(i) Meckesville Series. The Meckesville series consist of medium-textured, deep, well drained soils that have a dark-brown surface layer and a reddish-brown subsoil. These soils are mostly stone and are wooded. They have formed a pre-Wisconsin glacial till consisting of mixed red, brown, and gray sandstone and siltstone with some conglomerate and shale.

(j) Oquaga Series. The Oquaga series consist of moderately deep, well drained upland soils formed in glacial till and frost churned materials derived from reddish acid sandstone interbedded with shale. They have an extremely stony silt loam surface layer and a very channery loam or slaggy loam subsoil. Bedrock is about 26 inches.

(k) Very Stony Land. The mapping units in this miscellaneous land type consist of stones, boulders, and outcrops of rock. The areas are too steep and stony for any use except shrubs and slow-growing trees. In places, geologic erosion is keeping pace with the soil-forming process.

(1) Wellsboro Series. Wellsboro soils consist of deep, moderately well drained loamy soils of the glaciated uplands. These soils have a thick, compact, slowly permeable fragipan in the subsoil and a high water table that normally rises to within 18 inches of the surface during the winter and spring months. They have a moderate available moisture holding capacity, medium natural fertility and a few too many stone fragments.

3-08. Vegetation. The vegetative cover representative of the Pocono plateau region extends for miles in three directions from the project site. South of the project, however, the topography begins to abruptly fall to lower elevations where vegetation is more lush and supports greater numbers of conifers and oak. Hickory Run State Park, four miles south of the project, is generally 100 feet lower in elevation. Valleys of that lower elevation are broader than those of the project and therefore support greater concentrations of moisture-loving plant species. The lusher aspects of the lower elevations are reflected in the two largest valleys in the present project and to some extent in intermittent spots along the pool perimeter. For the large part, the project supports Pocono Plateau hard-woods at the higher elevations. Project modifications will not change the ratio of those two plant communities, but will present them further upstream on lands to be acquired. Refer to Appendix D, DM No. 10A for inventory and expanded discussion.

3-09. Land Use. Management of the project has little effect on the ecosystems within the presently limited project lands, except on the shoreline zone of the reservoir. Existing and proposed recreational facilities are designed to have a minimal impact on the environment and to preserve the character of the region as it extends into the Federal Reservation. A more detailed study of the area ecology can be found in Appendix D, DM No. 10A.

SECTION IV- WATER QUALITY DATA

4-01. Purpose of Sampling Program. The purpose of taking water samples at Walter Lake is to maintain a constant inventory of the water quality within the area influencing and influenced by the lake. Other sample sites, shown in Plate 1, indicate water quality upstream and downstream, as well as within the lake. Analysis of these samples gives an understanding of the effect of the lake on water quality:

a. The relationship to the water quality problems within the basin;

b. To provide warning of detrimental effects to water uses;

c. To determine effects of lake on water quality; and

d. To provide resource data.

4-02. Testing Procedures and Equipment. Post-impoundment water quality data has been collected periodically since April 1974. Prior to that time, only limited sporadic data collection efforts were made. Data available so far, together with discussions with the Pennsylvania Department of Environmental Resources, Water Quality Division, indicate that present water quality is good. No algae problems exist and standards for waste discharges above and below the dam are directed at maintaining high water quality.

Criteria set by the Commonwealth of Pennsylvania includes the following parameters: pH, dissolved oxygen (DO), temperature, bacteria, iron and total dissolved solids (TDS). The present data collection program covers pH, DO, temperature, and specific conductance as an indicator of TDS. The Corps data collection program also includes testing for Ortho Phosphate, Nitrate and Nitrite, Ammonia and total coliforms.

Water samples are collected under contract by Betz, Converse, & Murdoch, Inc. Stratification data is collected by personnel from the Philadelphia District Office. The results of this testing are tabulated in Appendix A of this report. The current Pennsylvania DER standards for fecal coliforms for swimming beaches is 200 FC/100 ml of sample.

District personnel in conjunction with personnel of the Northern Area Office, continued stratification monitoring at three sites within the lake from May to October 1980. The documented data can be found in Appendix B to this report. (Available in NAPEN-E files.)

As part of its operation of a state-wide water quality network, the PA DER operates four stations, one on the Lehigh River at the State Route 115 bridge, another on Tobyhanna Creek at the State Route 940 bridge, one on Bear Creek north of the dam and a station downstream of the dam.

Water quality standards have been established for the Lehigh River from its headwaters to the Francis E. Walter Dam. Those standards which are of concern are:

a. pH - Not less than 6.0 and not more than 8.5.

b. Dissolved Oxygen - No value less than 7.0 mg/^{1} (in the river).

No value less than 5.0 mg/1 at any point (in lakes, ponds, and impoundments).

c. Iron - Total iron not more than 1.5 mg/1.

d. Temperature - Not more than 5oF rise above natural temperatures or a maximum of 58oF.

e. Dissolved Solids - Not more than 500 mg/1 as a monthly average value, not more than 750 mg/1 at any time.

4-03. Data Available. Considerable data collected as a basis for project regulation are available for analysis. Water quality data, 1/ (temperature, dissolved oxygen, conductivity, pH, phosphorous, total dissolved solids, nitrate, nitrite, ammonia, iron, and total coliform) has been collected and documented on a regular continuing basis for the past six years. Additional data is available from other sources such as the Pennsylvania Department of Environmental Resources, U. S. Geological Survey, Pennsylvania Fish Commission and information collected and filed by the Philadelphia District, Corps of Engineers. During FY 81, the USGS has been involved in added water quality monitoring due to initiation of work on the modification of the dam. This work has involved analysis of bottom sediments at the major inflow points and sporadically after heavy rainfall. This data is available in the district files (NAPEN-E)

4-04. Reservoir Operation and Hydrology.

The methodology of operation of the project specifically designed for flood control, water storage and control monitoring is set forth in detail in the project Regulation Manual dated 29 December 1972. Briefly, that manual states that the existing project will be operated in the following manner. A more detailed discussion will be found in Appendix A, DM No. 10A, Reservoir elevation vs. total capacity; area and capacity curves, Plate 5.

a. Normal Operation. Normal operation is defined as the regulation necessary to maintain the reservoir as near Conservation Pool level (Elevation 1,300) as possible. The range of pool elevations for normal operation is from elevation 1,297 to elevation 1,306.

1/ Appendix A - Water Quality/Bacteriological Data

This allows for a fluctuation of nine feet, from three feet below to six feet above Conservation Pool level. The fluctuations within this range will be as infrequent as possible during periods of high recreational usage (June through September). During Fy 81 the Philadelphia District was operating F.E. Walter Lake for drought contingency water supply purposes. Normal pool elevation during April 7, 1981 to 30 Sept 1981 was 1392.0. This was temporary Storage Elevation. The total water supply storage available was 11.45 billion gallons, which included temporary storage approved by the North Atlantic Division Office. Normal regulation is therefore limited to the operations necessary to keep the reservoir at or near Conservation Pool level for recreation use, to meet water quality requirements, and to combat mosquito propagation.

b. Flood Control Operation

The operation of the reservoir for flood control is determined by any one of the following criteria:

1. Pool elevations greater than 1,306.0 feet (Conservation Pool level plus 6 feet).

2. District Office National Disaster Alert.

3. Reported river stages at control locations equal to, or more than flood stages indicated in the Operational Maintenance Manual.

4. Lehigh Basin rainfall reports or predictions of precipitation greated than 1 in./hr., or 2 inches in 6 hours.

5. Reservoir inflow rates in excess of 2,000 c.f.s.m or gate openings greater than 6.0 feet required for Normal Operation.

6. Basin snow cover having water equivalent of 3 inches or greater.

7. Reports of severe ice conditions or temporary constrictions at downstream locations.

8. Malfunction of gate operation equipment.

During any of these conditions, control of operations of the reservoir may revert to the District Office. The decision of whether control will revert to the District Office will be determined by the District Office after notification of the occurrence of any of the above situations.

Local Surface Water Hydrology

Approximately 20 percent of the township drains west into the Susquehanna River and the remainder of the land drains either directly or indirectly into the upper reaches of the Lehigh River.

The major receptor of runoff, which eventually reached the Lehigh River, is Bear Creek, just below Big Shiney Mountain. This creek flows in a southwesterly direction and continues to gain volume by receiving water from both the Meadow Run Ponds in the east and Lake Aleeda and the Wyoming Mountains region in the west. Throughout the upper reaches of Bear Creek the ground water table approaches surface exposure as is indicated by numerous swamp conditions in the northern central portion of the township.

Upon reaching the center of the township, Bear Creek assumes a southerly flow pattern and eventually drains into Bear Creek Lake. This lake, with a surface area of approximately 100 acres, has a dam at its most southerly boundary. Water passing over the spillway constitutes the continues flow of Bear Creek.

Bear Creek continues to flow in a southeasterly direction for 1,600 feet where it enters and impoundment which has been constructed by the Pennsylvania Gas ans Water Company. When the rate of flow in Bear Creek is substantially high, water is pumped from the impoundment to Crystal Lake for use in public water qupply systems in Wright and Fairview Townships.

Water passing over the impoundment continues to flow in a southeasterly direction while receiving runoff from both extreme boundaries of the southern portion of the township. Bear Creek eventually empties into the Lehigh River which is immediately impounded by the Francis E. Walter Dam.

At the present time, the flow rate through the dam is monitored by a gaging station located approximately 1 mile downstream of the dam. The fraction of the total flow through the dam which results from the discharge of Bear Creek has been monitored from a gaging station just below Bear Creek Lake, which is operated by the Pennsylvania Gas and Water Company. Table 2 shows the flow characteristics of the Lehigh River below the Francis E. Walter Dam and the flow of Bear Creek at the Pennsylvania Gas and Water Company impoundment.

SECTION V - INTERPRETATION OF DATA

5-01. General Post-Impoundment Conditions. In general, accumulated data indicated the reservoir is of high water quality. The data indicated a favorable comparison with water quality criteria established by Pennsylvania Department of Environmental Resources as outlined in "Chapter 93: Water Quality Criteria."

During periods of heavy rainfall, streams contributing runoff to the lake as well as the lake exhibit a moderate drop in pH while the ammonia nitrogen levels remained within the Pennsylvania DER standards of 0.5 mg/l. After the flushing period, the levels of these and other parameters remained uniform and exhibited conformance to established water quality criteria. During Fy 81 it was noticed the an order was eminating from the abutement area. This oder had a smell similar to H_2S (hydrogen sulfide).

After investigation, it was determined that the gas was coming up through the reservoir pool. This is most likely because of vegetation decay caused by the raising of the normal pool. Because the pool was raised for several months, the vegetation and trees completely covered had begun to die off and this organic decay resulted in H_2S gas being released into the pool and later rising to the surface.

The bacteria coliform samples are collected at the same time as the water quality samples and are processed under contract at a certified laboratory in accordance with procedures outlined in Standard Methods for the Examination of Water and Waste Water, 14th Edition. These data are outlined in Appendix A of this report.

The District also plans to continue the stratification testing that was initiated, in 1975. 1/ Data derived will be useful in determining thermoclines and analyzing for selected chemical parameters at various levels throughout the lake.

5.02 Chemistry Data

"See Appendix A"

5.03. Fishery. The quality of the waters in the present 90 acres pool generally meet State Department of Health standards for body-contact water sports, although none are permitted at this lake. Periodic water samplings taken from various locations in the tributaries show a summertime average MPN/100 ml for fecal coliform organisms of less than 10, and an averge MPN/100 for total coliform of 20. The pool waters have maintained an adequate ph level. This combination of factors combined with good water release management has resulted in the maintenance of good cold-water fisheries both downstream of the dam and in the upstream major tributaries.

1/ Stratification water samples - (Appendix B) Philadelphia District

A popular warm-water fishery is also maintained in the impoundment as a result of water quality and management practices. Both of these fisheries are supplemented by periodic stocking by the Pennsylvania Fish Commission. There have been no occurrences of algal blooms or other warnings of eutrophication recorded at the project. Access to the lake for most fishermen is from the boat launching area on the right bank of the dam, or by hiking along the shoreline. Most fishing at Francis E. Walter Lake is done from boats. Downstream fishing sites in the reservoir tail waters and the Lehigh River are accessible by hiking in from the parking lot by the spillway, the gaging station road, or from the Fawn Run parking lot.

The State Fish Commission has stocked Francis E. Walter Reservoir and the downstream areas with species of warm water gamefish and trout on a annual basis. Trout stocking is done in recognition of the potential of the reservoir to support a cold water fishery and to augment the put-and-take stocking practice which is a part of the Commonwealth of Pennsylvania's trout management program. The Pennsylvania Fish Commission has determined that the lake is most suitable for walleye and possible smallmouth bass. The steep slope of the shoreline will limit spawning success of many other species.

1981 Pennsylvania Fish Stocking at Walter Lake.

March 23	4,750 Brook Trout
April 30	4,750 Brook Trout
Sept 28	3,000 Tiger Muskellunge

SECTION VI - RECOMMENDATIONS AND PROPOSED STUDIES

6-01. General. The following recommendations are made relative to the water quality management and control at Francis E. Walter Dam and Reservoir.

a. Continue the present sampling frequency to help maintain surveillance over the water quality in the lake.

b. Correlate data collected from other agencies and establish their sampling locations, procedures, and equipment used for testing.

c. Support state efforts in collection and analysis of algae and coliform data for the lake.

d. An expanded program of sampling chemical profiles in the lake, especially while the lake is thermally stratified to establish the relationship of thermal stratification to chemical stratification.

e. Enlist services of the Pennsylvania DER's Water Quality Section and laboratory facilities to expand our present sampling points and test for additional physio-chemical, bacteriological and biological parameters.

f. Investigate the source of low pH levels in the Reservoir.

g. Investigate the source of bacterial contamination.

h. Additional recommendation located in Appendix A.

6-02. Findings and Conclusions. The water sampling program will continue essentially unchanged for FY 1982 at Francis E. Walter Lake and its tributaries.

The water sampling data collected during calendar year 1981 indicated that the water quality in Francis E. Walter Lake remains within the standards established by Pennsylvania (DER) and the U. S. Environmental Protection Agency. In general, following periods of heavy precipitation, there is a slight increase in ammonia nitrogen and phosphorous levels with a decrease in the pH levels. This is associated more with runoff from surrounding areas and is not a direct function of the reservoir.

Bacteriological data 1/ recorded at stream inflows are within the criteria established by Pennsylvania (DER).

Results for the parameters, such as dissolved oxygen, phosphorous, total dissolved solids, conductance, ammonia, nitrate and nitrite have remained fairly uniform and are within allowable limits for the water samples collected and analyzed during the testing period.

1/ Appendix A

APPENDIX A

WATER QUALITY/BACTERIOLOGICAL DATA

Betz • Converse • Murdoch • Inc

FRANCIS E. WALTER LAKE WATER QUALITY SAMPLING

INTRODUCTION

The Philadelphia District of the Corps of Engineers has established a Water Quality Monitoring Program at a numerous lakes within their jurisdiction, in order to ensure that good water quality is maintained and that the Pennsylvania Water Quality Standards outlined in Chapter 93 are being met. Betz•Converse•Murdoch•Inc. (BCM), under contract to the Philadelphia District, has conducted a water chemistry testing program at F. E. Walter Lake for water year 1981 (October 1980 to September 1981). The following report presents the results of the testing program and an analysis of the data.

SAMPLING PROCEDURES

The F. E. Walter Dam and Reservoir is located on Lehigh River, a tributary to the Delaware River in Luzerne, Carbon and Monroe Counties in northeast Pennsylvania. The following five stations were sampled 17 times during water year 1981; once a month during December, January, February, March, April and September, and twice a month during the summer months:

W-1 Downstream of Dam
W-2 Boat Launch
W-3 Tobyhanna Creek
W-4 Lehigh River - upstream of lake
W-5 Bear Creek

At each station, water samples were collected just below the surface, iced, and delivered to the BCM analytical laboratory within 24 hours. They were analyzed for biochemical oxygen demand (BOD_5), total phosphorus, ammonia nitrogen, nitrate nitrogen, nitrite nitrogen and total dissolved solids. All analysis were performed in accordance with the current procedures approved by the U. S. Environmental Protection Agency. Dissolved oxygen, pH, temperature and conductivity were measured in the field. In addition, lake samples were collected in sterile bottles five times during the year for bacteriological analysis. The drinking water sources at F. E. Walter is sampled in April, June and August at the COE headquarters building and at the lake picnic area for bacteriological analysis.

PENNSYLVANIA WATER QUALITY STANDARDS

The F. E. Walter impoundment is listed as having the protected use for High Quality-Cold Water Fisheries (WQ-CWF) in Pennsylvania Chapter 93 Water Quality Standards. Table 1 presents the Pennsylvania Water Quality Standards for the F. E. Walter impoundment for the parameters analyzed in the 1981 water year sampling program.

WATER QUALITY RESULTS

Table 2 presents the water quality data collected at the F. E. Walter impoundment during water year 1981. The following figures present plots of BOD_5, total phosphorus, ammonia, nitrate, total dissolved solids, dissolved oxygen, temperature and conductivity for the five stations. The following is a discussion by parameter of the sampling results.

Biochemical Oxygen Demand (BOD) and Dissolved Oxygen

Dissolved oxygen levels were below the 7.0 mg/l state standards F. E. Walter at site W-2, the lowest being 5.5 in 2/25/81. Dissolved oxygen levels are inversely related to temperature and dissolved solids concentrations resulting in a decrease of oxygen levels during the summer months. Biochemical oxygen demand (BOD_5) values were generally <5 mg/l, except for a one relatively high level of 7 mg/l on 3/26/81 at Station W-1 which is downstream of the dam.

Nutrients

The concentrations of phosphorus and nitrogen compounds found in the lake are critical to the eutrophication process. High levels of nutrients speed-up the aging process of the lake by excessive growths of algae and/or macrophytes. The concentrations of nitrogen and phosphorus necessary at the beginnning of the growing season to produce new populations of algae were suggested by Sawyer (1947) to be 0.30 and 0.015 mg/l, respectively. Vollenweider (1968) states that .02 mg/l of total phosphorus is the eutrophication danger level. About one-third (28 or 83) phosphorus values recorded during water year 1981 are less than or equal to 0.02 mg/l. The mean nitrate level recorded as nitrogen was 3.8 mg/l with none of the values exceeding 10 mg/l (which is the state standard). The maximum value was 2.8 mg/l recorded August 11, 1981 at Station W-3, Tobyhanna Creek.

Ammonia concentrations are important in lake dynamics not only because they serve as a nutrient source, but because un-ionized ammonia can be toxic to aquatic organisms. Ammonia levels did not exceed 0.5 mg/l at F. E. Walter Lake.

Total Dissolved Solids and Conductibity

Specific conductance is a measure of the ability of the unit volume of material to conduct electric current. In water this ability is directly related to the concentrations of ions, and therefore is related to the concentration of dissolved solids. Water quality criteria for the F. E. Walter impoundment require that the monthly average total dissolved solids not exceed 500 mg/l or that it exceeds 750 mg/l at any one time. The data show that these standards were exceeded once on December 30, 1980. However, the exceedingly high value recorded on this date (1,419 mg/l) may be a sampling anomaly especially since the dissolved solids and conductivity levels remained fairly low on other dates.

pH

The pH values range from 4.4 to 7.5. Many of these values are below the state standards, especially during the summer months. These high values reflect the nature of the wateshed and are most likely a result of precipitation events in combination with the higher water levels recently maintained at F. E. Walter.

Bacteria

Samples were collected at all four stations above the dam on March 26, May 27, June 23, July 22, and August 11 for analysis of fecal coliform, total coliform and fecal streptococcus. The state bacteria standard only applies to fecal coliform which is 200 per 100 milliliters during the swimming season. This standard was exceeded twice, once at W-5 (Bear Creek) and once at W-3 (Tobyhanna Creek). Both values were 400 per 100 ml. Fecal coliform to fecal streptococcus ratios are commonly used as an indicator of the bacterial source. Ratios greater than 4 are said to indicate human pollution while those less than 0.7 indicate animal contamination. Coliform/streptococcus ratios vary considerably at the F. E. Walter impoundment, but the high ratios may indicate some human sources of contamination. The drinking water samples yielded no evidence of bacterial contamination.

SUMMARY

The F. E. Walter impoundment shows very good water quality based on analysis during water year 1981. The high dissolved oxygen levels recorded are good in most cases.

RECOMMENDATIONS

It is recommended that the following studies be done to make the COE lake studies more meaningful:

- A watershed analysis to determine whether the low pH values are due to natural background conditions or a pollution source. Lower pH levels can be detrimental to game fisheries.
- Precipitation data should be reviewed and used to calculate nutrient loadings at particular times. The data can be used to explain anomolies in other parameters.
- The previously collected of water quality data should be stored in a computerized data management system so that annual trends can be assessed and a more meaningful analysis conducted.
- Additional bacterial sampling should be instituted to trace the source of possible human contamination of the lake.

Literature Cited:

Sawyer C. N 1947. Fertilization of Lakes by agricultural and urban drainage. New England Water Works Association. 61: 109-127.

Vollenweider, R. A. 1968. The scientific basis of lake and stream eutrophication, with particular reference to phosphorus and nitrogen as eutrophication factors. Tech. Rep. OECD, Paris DAS/DSI/68; 27: 1-182.

TABLE 1

PENNSYLVANIA WATER QUALITY STANDARDS

Lehigh River - Main Stem, Source to Route 903 Bridge at Jim Thorpe

Dissolved Oxygen - No value less than 7.0 mg/l

Bacteria - During the swimming season (May 1 through September 30), the fecal coliform level shall not exceed a geometric mean of 200 per 100 milliliters (ml), based on five consecutive samples, each sample collected on different days; for the remainder of the year, the fecal coliform level shall not exceed a geometric mean of 2,000 per 100 ml based on five consecutive samples collected on different days.

Nitrite plus Nitrate - Not to exceed 10 mg/l as nitrogen

pH - Not less than 6.0 and not more than 9.0

Temperature - No rise when ambient temperature is 58°F or above; not more than a 5°F rise above ambient temperature until stream temperature reaches 58°F; not to be changed by more than 2°F during any one-hour period.

Total Dissolved Solids - Not more than 500 mg/l as a monthly average value; not more than 750 mg/l at any one time.

Source: PA Chapter 93 Water Quality Standards, Title 25, Part 1, Subpart C. Adopted August 21, 1979.

Table 2

F.E.WALTER LAKE WATER QUALITY SAMPLING WATER YEAR 1981

MM/DD/YY	SITE	BOD	TP-P	NH3-N	NO3-N	NO2-N	DS	DO	pH	TEMP	COND	FC	TC	FS
10/29/80	1	<3	0.02	0.07	<0.10	<0.10	72	12.5	6.9	9.0	48			
10/29/80	2	<3	0.02	0.07	0.11	<0.10	70	10.6	6.9	12.0	48			
10/29/80	3	<3	0.03	0.06	0.58	<0.10	41	10.0	6.9	10.0	48			
10/29/80	4	<3	0.01	0.06	<0.10	<0.10	58	11.8	6.8	8.0	50			
10/29/80	5	<3	0.01	0.06	0.34	<0.10	47	11.6	6.8	8.0	46			
11/12/80	1	<2	<0.01	0.11	<0.10	<0.10	37	11.8	6.7	6.0	54			
11/12/80	2	<2	<0.01	0.26	<0.10	<0.10	33	9.0	5.7	9.0	50			
11/12/80	3	3	<0.01	0.11	<0.10	<0.10	25	10.2	6.6	8.5	45			
11/12/80	4	<2	<0.01	0.16	<0.10	<0.10	37	10.2	6.8	8.8	58			
11/12/80	5	2	<0.01	0.37	0.19	<0.10	42	10.5	6.0	7.0	50			
11/25/80	1	<3	0.03	0.26	0.10	<0.10	48	11.8	6.6	3.0	48			
11/25/80	2	<3	0.02	0.18	0.10	<0.10	31	11.8	5.6	3.0	50			
11/25/80	3	<3	0.03	0.17	0.10	<0.10	41	10.2	6.6	2.0	55			
11/25/80	4	<3	0.05	0.13	0.16	<0.10	45	9.6	6.0	2.0	58			
11/25/80	5	<3	0.03	0.18	0.10	<0.10	44	10.4	6.6	2.0	48			
12/30/80	1	<2	0.08	0.02	0.42	<0.10	82	13.5	6.0	3.0	26			
12/30/80	2	3	0.07	0.02	0.27	<0.10	34	11.0	7.0	2.0	28			
12/30/80	3	4	0.07	0.02	0.30	<0.10	1419	13.8	5.8	2.0	7007			
12/30/80	4	3	0.05	0.01	0.25	<0.10	45	14.0	6.2	3.0	49			
12/30/80	5	3	0.07	0.02	0.20	<0.10	57	12.2	6.5	2.0	48			
01/14/81	1	No samples because lake was completely frozen.												
01/14/81	2													
01/14/81	3	4	0.01	0.01	0.35	<0.10	55	12.4	5.8	1.0	53			
01/14/81	4	4	0.08	0.02	0.25	<0.10	70	13.8	6.8	1.0	54			
01/14/81	5	5	0.02	<0.01	0.25	<0.10	57	12.0	6.8	2.0	85			
02/25/81	1	3	0.07	0.01	0.21	<0.10	62	10.8	6.9	4.0	50			
02/25/81	2	2	0.06	0.01	0.39	<0.10	50	5.5	7.0	5.0	58	10	80	
02/25/81	3	<2	0.07	0.02	0.25	<0.10	120	11.8	6.5	4.0	60	10	150	
02/25/81	4	<2	0.06	0.03	0.25	<0.10	67	12.2	6.5	4.0	30	3	150	
02/25/81	5	2	0.07	0.02	0.18	<0.10	50	12.8	6.7	4.0	45	10	25	
03/26/81	1	7	0.04	<0.01	0.23	<0.10	74	12.6	7.3	5.0	35			
03/26/81	2	<2	0.03	0.01	0.23	<0.10	55	12.4	7.4	4.0	30	6	600	0
03/26/81	3	<2	0.06	<0.01	0.23	<0.10	68	12.0	7.3	5.0	30	0	7000	0
03/26/81	4	<2	0.03	<0.01	0.17	<0.10	37	10.8	7.2	6.0	35	0	500	0
03/26/81	5	<2	0.03	<0.01	0.11	<0.10	109	13.4	7.5	4.0	35	0	700	0
04/28/81	1	<3	0.03	<0.01	0.13	<0.10	54	12.0	6.7	7.0	50			
04/28/81	2	<3	0.03	<0.01	0.12	<0.10	42	11.2	6.9	11.0	72			
04/28/81	3	<3	0.06	<0.01	0.09	<0.10	39	11.0	7.2	11.0	65			
04/28/81	4	<3	0.03	<0.01	0.06	<0.10	41	12.4	7.0	11.0	55			
04/28/81	5	<3	0.05	<0.01	<0.06	<0.10	50	11.3	6.9	11.0	50			
05/12/81	1	<3	0.04	<0.01	0.16	<0.10	51	12.4	5.4	9.0	52			
05/12/81	2	<3	0.07	<0.01	0.14	<0.10	38	11.4	7.1	15.0	50			
05/12/81	3	<3	0.06	<0.01	0.18	<0.10	56	10.2	5.4	15.0	48			
05/12/81	4	<3	0.06	<0.01	0.14	<0.10	66	10.0	5.5	14.0	45			
05/12/81	5	<3	0.03	<0.01	0.21	<0.10	55	10.4	4.4	13.0	73			
05/27/81	1	3	<0.01	0.04	0.10	<0.10	<1	11.8	6.3	15.0	48			
05/27/81	2	5	<0.01	0.02	<0.10	<0.10	<1	9.4	6.0	21.0	50	0	500	3
05/27/81	3	<3	0.02	0.02	0.20	<0.10	15	9.3	6.2	20.0	42	9	1000	2
05/27/81	4	3	<0.01	0.01	0.20	<0.10	09	10.4	6.2	19.0	46	14	300	2
05/27/81	5	3	<0.01	0.01	0.20	<0.10	01	9.4	6.8	18.0	47	7	460	3

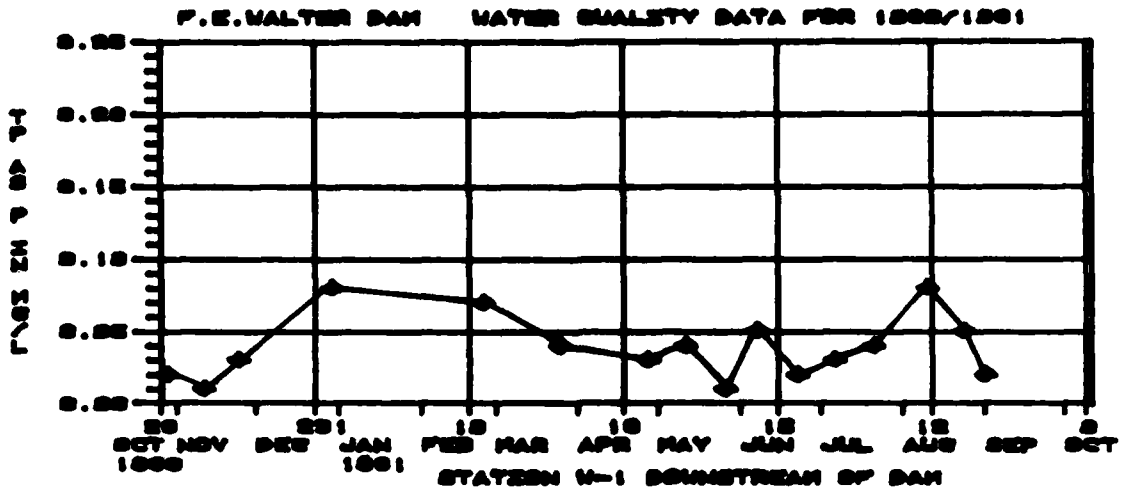
Continued on next page

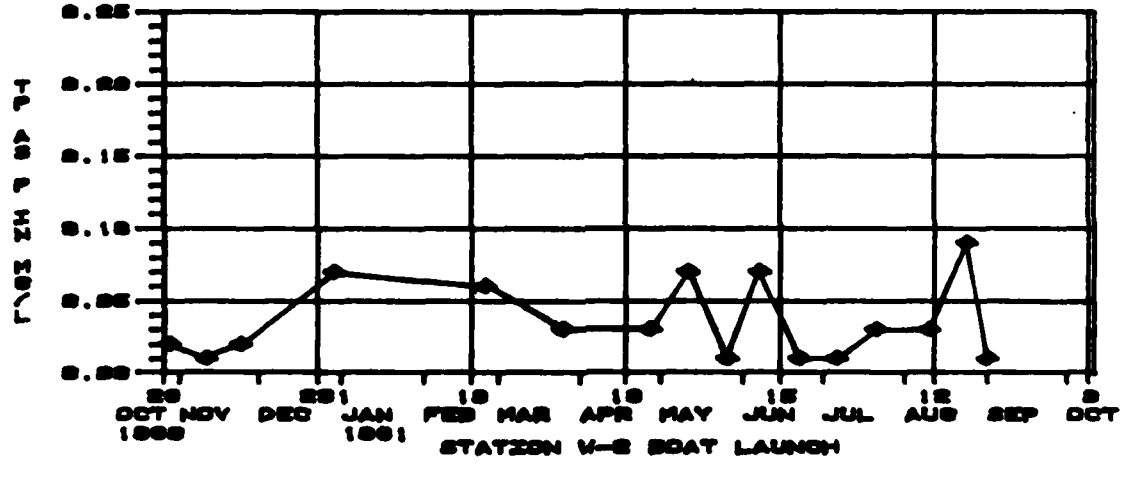
Table 2

F.E.WALTER LAKE WATER QUALITY SAMPLING (Continued)

MM/DD/YY	SITE	BOD	TP-P	NH3-N	NO3-N	NO2-N	DS	DO	pH	TEMP	COND	FC	TC	FS
04/08/81	1	3	0.05	0.04	2.70	<0.10	33	11.6	5.0	16.0	46			
04/08/81	2	3	0.07	<0.01	0.21	<0.10	30	7.8	5.3	23.0	45			
04/08/81	3	3	0.04	0.04	0.24	<0.10	38	9.2	5.4	21.0	44			
04/08/81	4	<3	0.08	0.04	0.41	<0.10	29	8.8	5.5	20.0	55			
04/08/81	5	<3	0.04	<0.01	<0.24	<0.10	43	9.5	4.6	20.0	50			
04/23/81	1	3	0.02	0.05	0.50	<0.10	54	9.9	5.4	16.0	46			
04/23/81	2	3	<0.01	<0.01	0.10	<0.10	30	7.4	5.6	22.0	45	3	140	40
04/23/81	3	<3	0.03	0.01	0.30	<0.10	37	8.9	5.6	20.0	45	55	200	10
04/23/81	4	3	0.04	<0.01	0.80	<0.10	50	9.9	6.0	20.0	45	53	400	11
04/23/81	5	3	0.02	0.15	0.30	<0.10	26	9.1	4.8	18.0	54	400	1200	10
07/07/81	1	<3	0.03	0.12	1.50	<0.10	54	10.4	5.5	18.0	48			
07/07/81	2	<3	<0.01	0.02	1.20	<0.10	51	8.1	5.8	24.0	44			
07/07/81	3	<3	0.02	0.02	0.40	<0.10	51	7.8	5.7	23.0	42			
07/07/81	4	<3	0.03	0.03	0.40	<0.10	43	10.2	6.0	23.0	46			
07/07/81	5	<3	0.01	<0.01	2.00	<0.10	51	9.4	6.1	20.0	57			
07/22/81	1	3	0.04	0.22	0.03	<0.10	19	9.8	5.5	18.0	40			
07/22/81	2	4	0.03	0.03	0.10	<0.10	24	7.8	5.0	23.0	55	0	200	0
07/22/81	3	3	0.04	0.03	0.10	<0.10	55	9.4	5.6	20.0	48	400	800	50
07/22/81	4	<3	0.04	0.03	0.11	<0.10	49	10.2	6.2	20.0	57	0	300	70
07/22/81	5	3	0.05	0.03	0.10	<0.10	29	9.3	6.4	18.0	60	110	200	220
08/11/81	1	<3	0.08	0.27	1.70	<0.10	44	8.9	5.6	19.0	40			
08/11/81	2	4	0.03	<0.01	2.10	<0.10	61	7.9	5.4	24.0	32	<10	120	20
08/11/81	3	<3	0.04	0.01	2.80	<0.10	52	9.3	5.8	21.0	36	20	600	30
08/11/81	4	<3	0.04	<0.01	1.40	<0.10	54	10.2	6.2	22.0	38	20	220	<10
08/11/81	5	<3	0.03	<0.01	1.80	<0.10	104	8.7	5.2	18.0	42	40	130	20
08/25/81	1	<3	0.05	0.30	<0.01	<0.10	49	8.6	6.3	20.0	36			
08/25/81	2	<3	0.09	0.03	<0.01	<0.10	45	6.1	5.7	22.0	35			
08/25/81	3	<3	0.14	0.01	<0.01	<0.10	45	8.6	5.9	19.0	42			
08/25/81	4	<3	0.19	0.02	<0.01	<0.10	47	9.2	7.1	21.0	44			
08/25/81	5	<3	0.11	0.01	<0.01	<0.10	35	8.9	7.0	19.0	39			
09/02/81	1	<3	0.02	0.31	<0.01	<0.10	44	8.1	6.8	19.0	48			
09/02/81	2	<3	<0.01	0.02	<0.01	<0.10	58	6.6	6.6	20.0	36			
09/02/81	3	3	<0.01	<0.01	0.07	<0.10	45	9.2	7.4	18.0	38			
09/02/81	4	4	<0.01	<0.01	0.13	<0.10	43	9.0	7.4	18.0	44			
09/02/81	5	<3	<0.01	<0.01	0.10	<0.10	47	8.4	6.8	18.0	48			
MAXIMUM		7.0	0.19	0.37	2.80		1419	14.0	7.5	24.0	7007			
MINIMUM		2.0	0.01	0.01	0.01		1	5.5	4.4	1.0	24			
RANGE		5.0	0.18	0.36	2.79		1418	8.5	3.1	23.0	6981			
MEAN		3.0	0.04	0.06	0.38		64	10.3	6.3	12.9	131			
STAN DEV		.72	0.03	0.08	0.59		152	1.8	0.7	7.5	764			

All units are mg/l except: pH in standard units; Temp in degrees centigrade; Conductivity in umhos/cm and the bacteriological results in #/100 ml.


F.E.WALTER DAM WATER QUALITY DATA FOR 1990/1991
TOTAL PHOSPHORUS MG/L
0.25
0.20
0.15
0.10
0.05
0.00
20 1 10 10 15 12 8
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT
1990 1991
STATION W-1 DOWNSTREAM OF DAM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0.20
0.15
0.10
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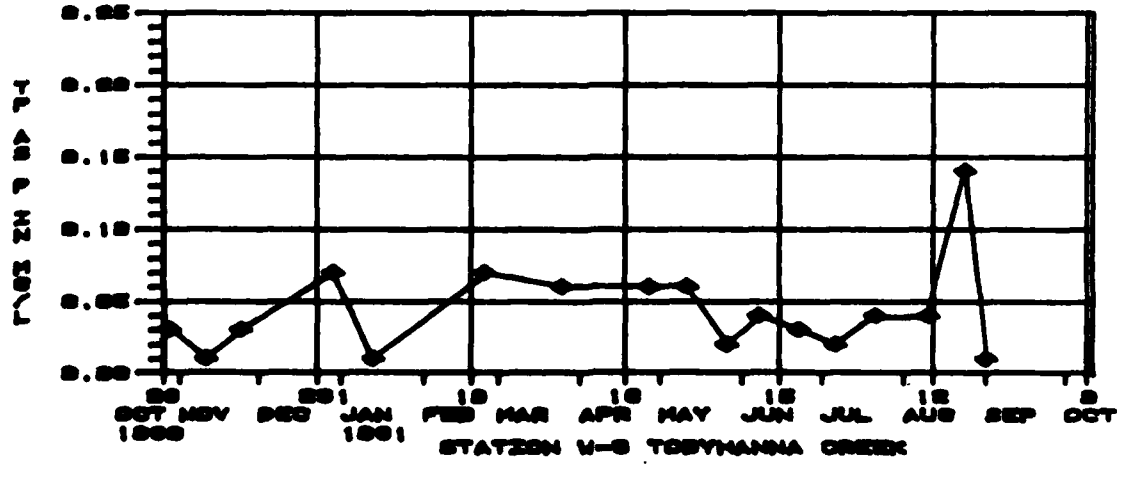
20 1 10 10 15 12 8
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT
1990 1991
STATION W-2 BOAT LAUNCH


TOTAL PHOSPHORUS MG/L
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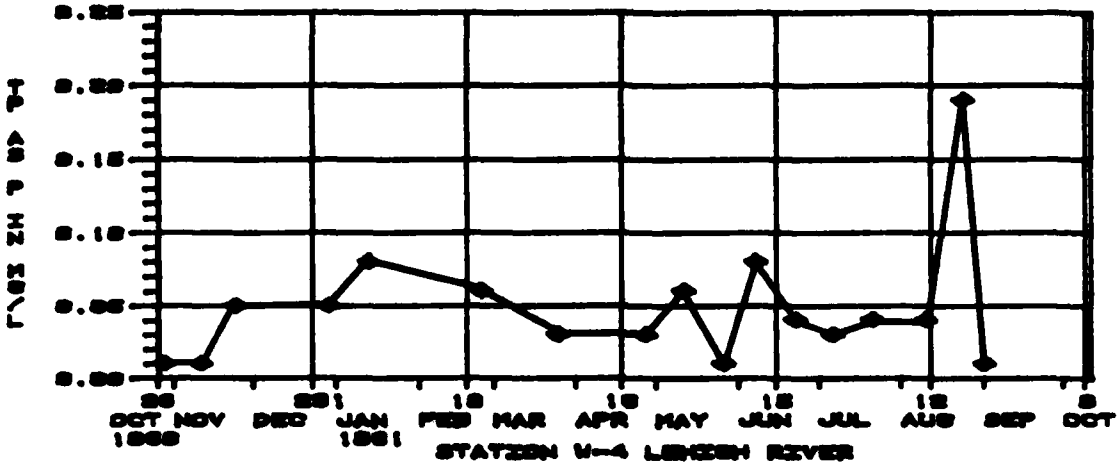
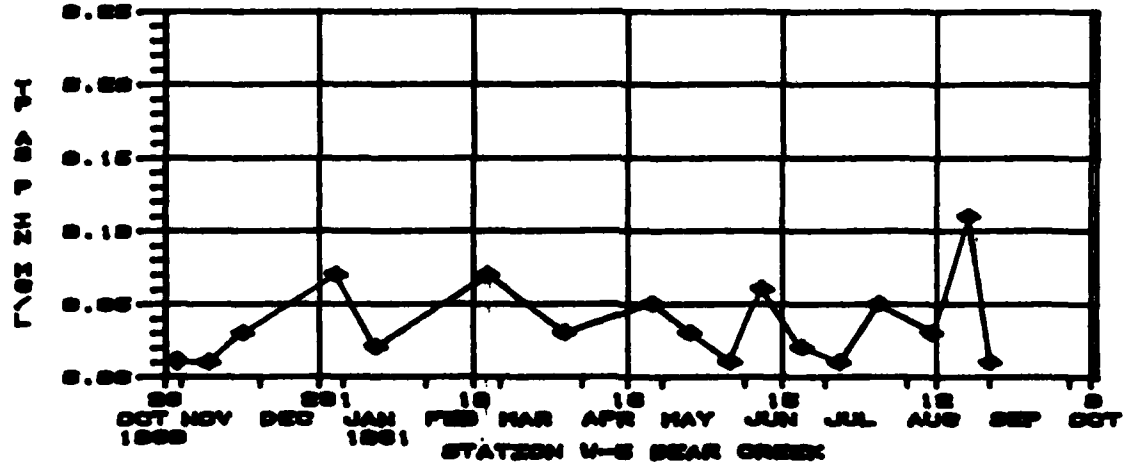
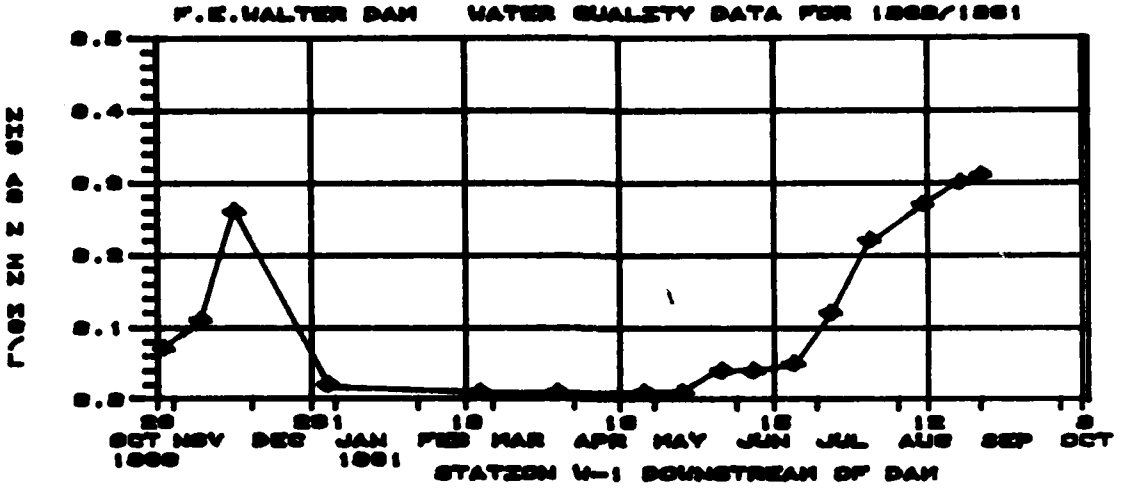
0.20
0.15
0.10
0.05
0.00
20 1 10 10 15 12 8
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT
1990 1991
STATION W-3 TOBYHANNA CREEK

F.E.WALTER DAM WATER QUALITY DATA FOR 1980/1981

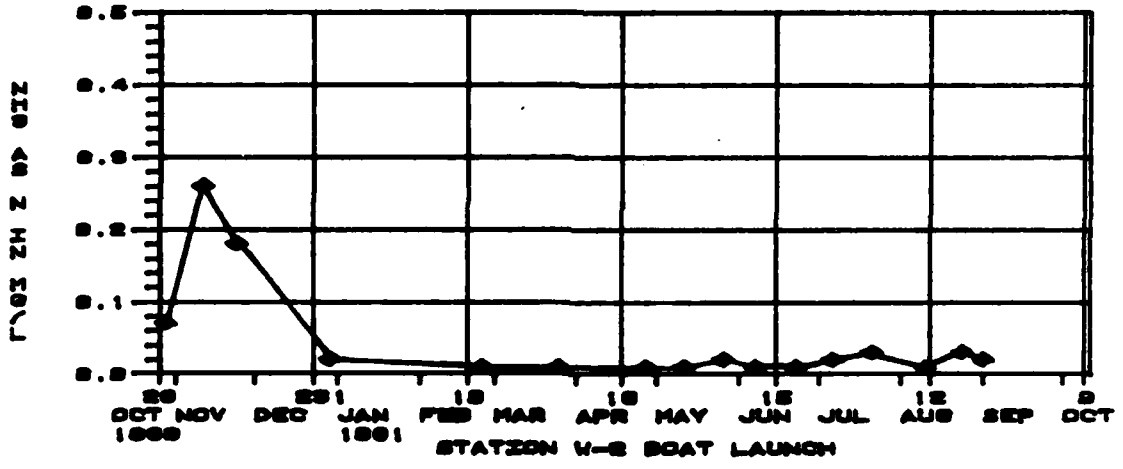




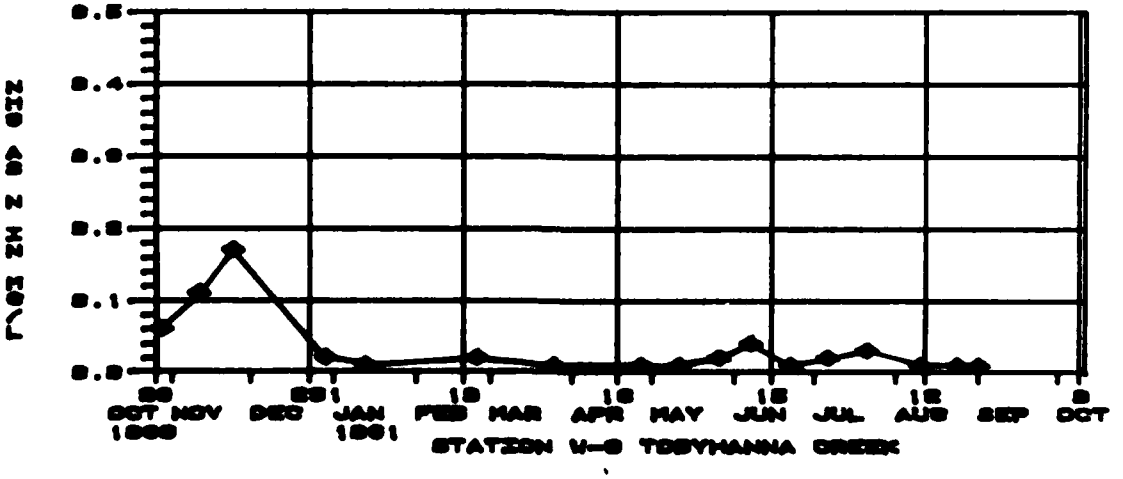
F.E.WALTER DAM WATER QUALITY DATA FOR 1980/1981



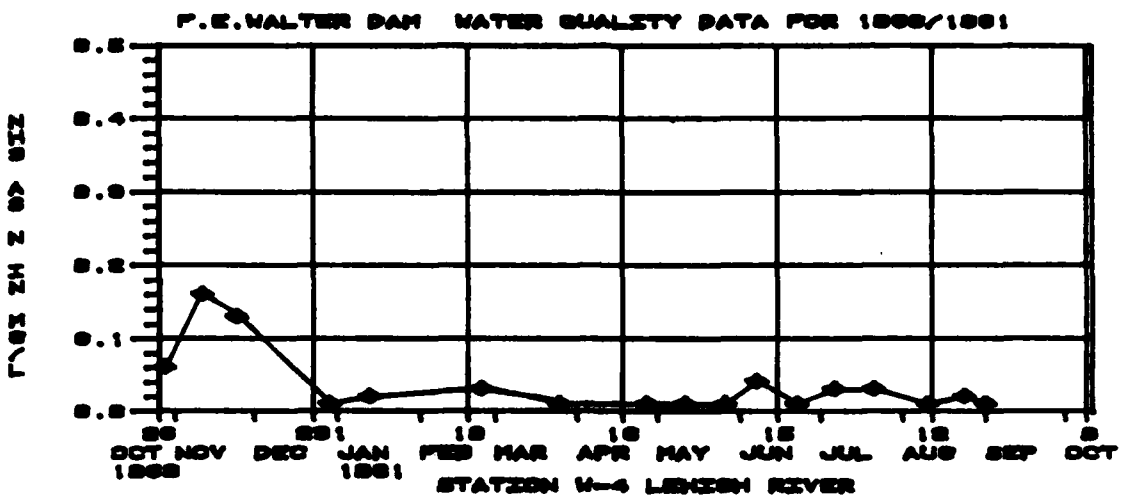
STATION W-1 DOWNSTREAM OF DAM

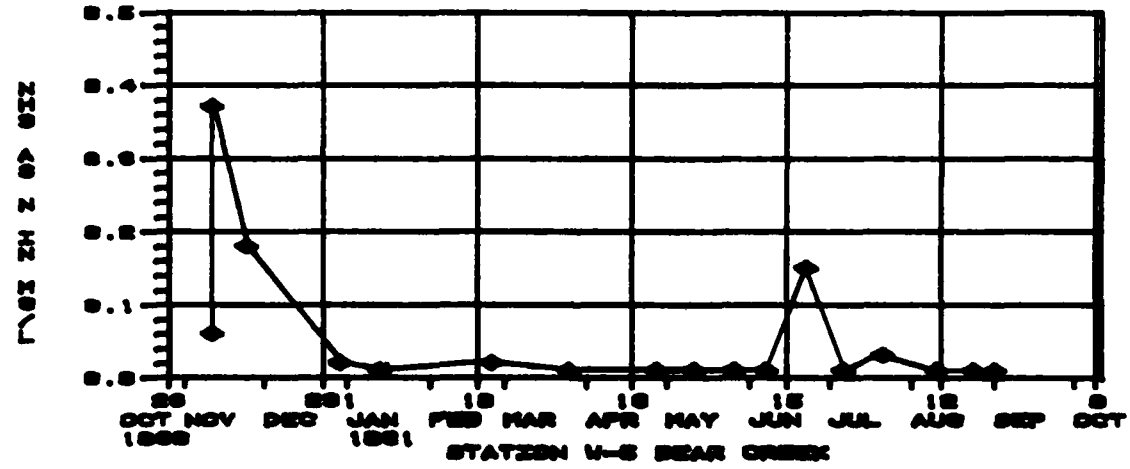


STATION W-2 BOAT LAUNCH

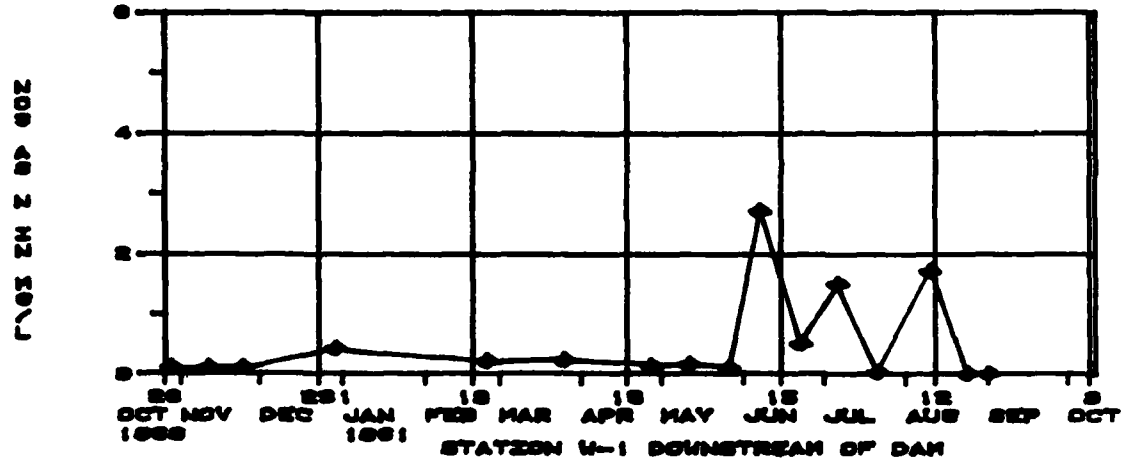


STATION W-3 TOBYHANNA CREEK

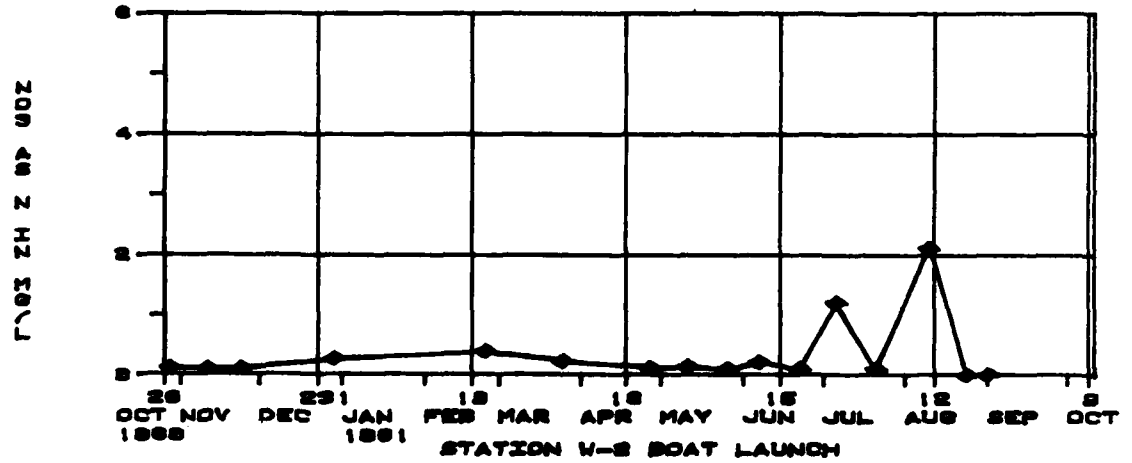

F.E.WALTER DAM WATER QUALITY DATA FOR 1980/1981
ZINC (MG/L)
0.5
0.4
0.3
0.2
0.1
0.0
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT
1980 1981
STATION W-4 LEHIGH RIVER


ZINC (MG/L)
0.5
0.4
0.3
0.2
0.1
0.0
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT
1980 1981
STATION W-6 BEAR CREEK

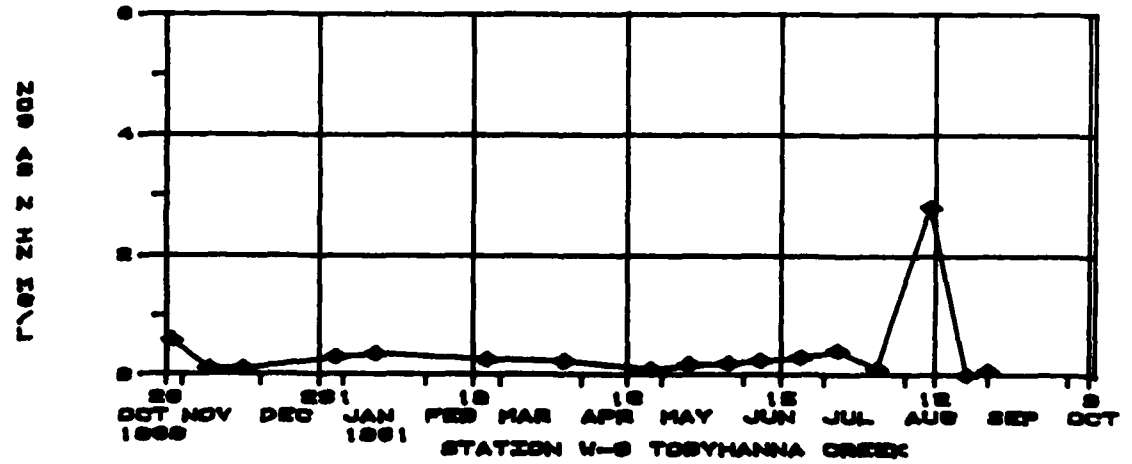
F.E.WALTER DAM WATER QUALITY DATA FOR 1990/1991



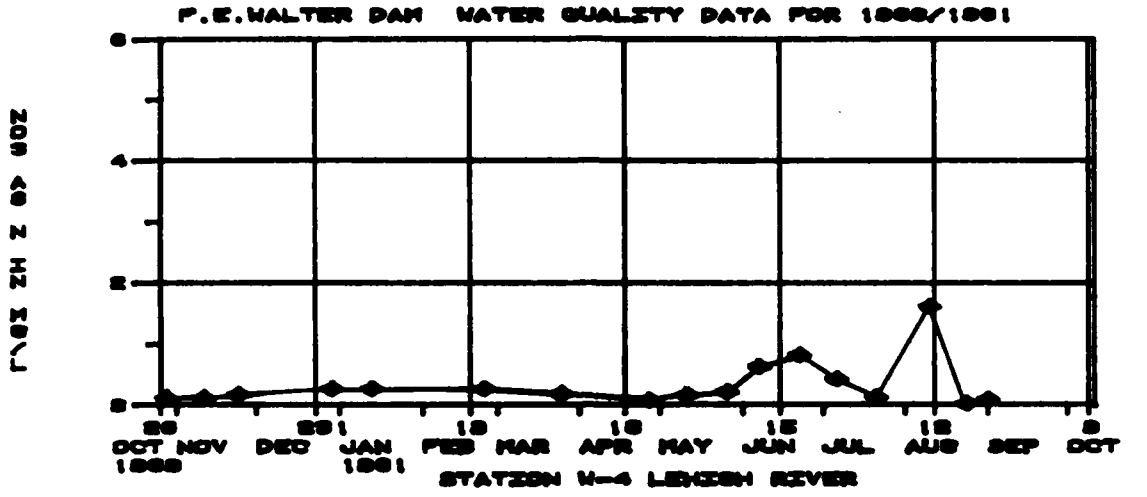
STATION W-1 DOWNSTREAM OF DAM

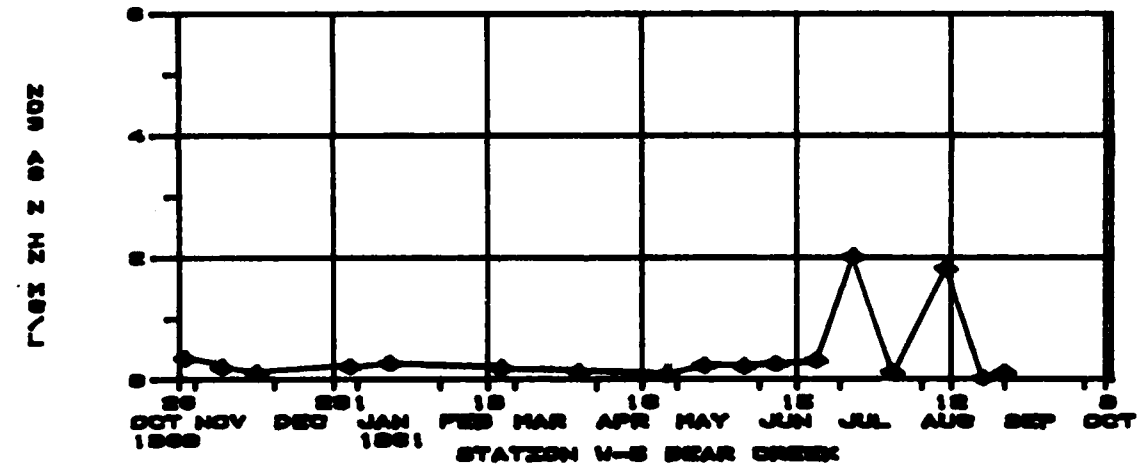


STATION W-2 BOAT LAUNCH



STATION W-3 TOBYHANNA CREEK

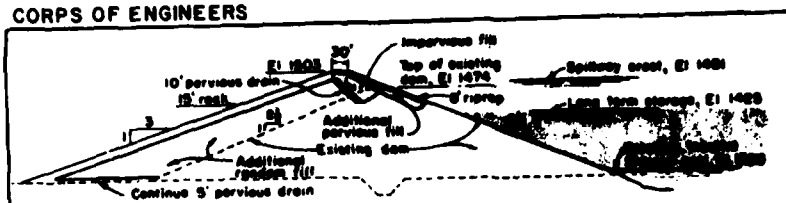

P.E.WALTER DAM WATER QUALITY DATA FOR 1990/1991
MG/L
0
2
4
6
20
OCT
1990
NOV
DEC
JAN
1991
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
STATION W-4 LEHIGH RIVER


MG/L
0
2
4
6
20
OCT
1990
NOV
DEC
JAN
1991
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
STATION W-5 BEAR CREEK

APPENDIX B
(Data Available NAPEN-E Files)

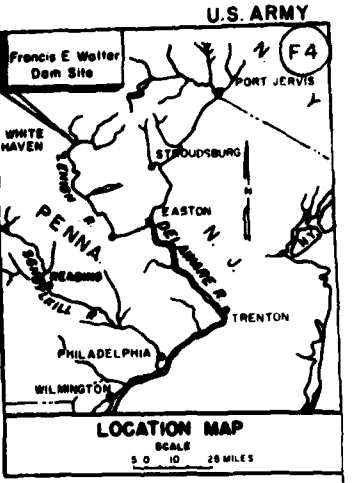
CORPS OF ENGINEERS

U.S. ARMY



SECTION-PROPOSED MODIFIED DAM

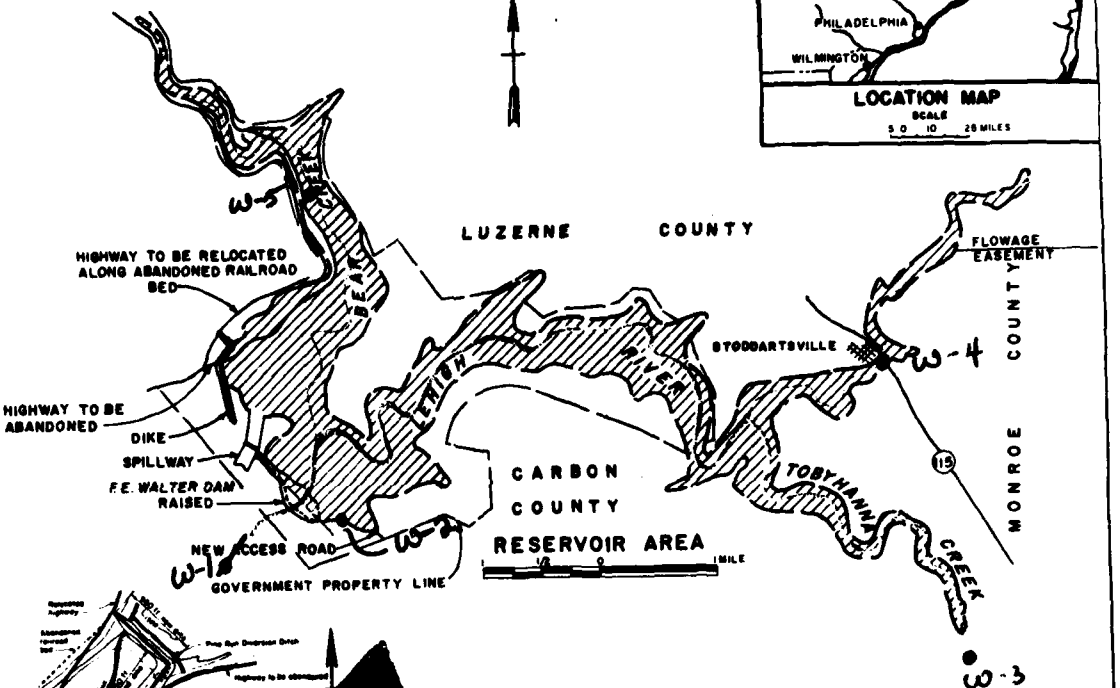
100 0 100 200 FEET

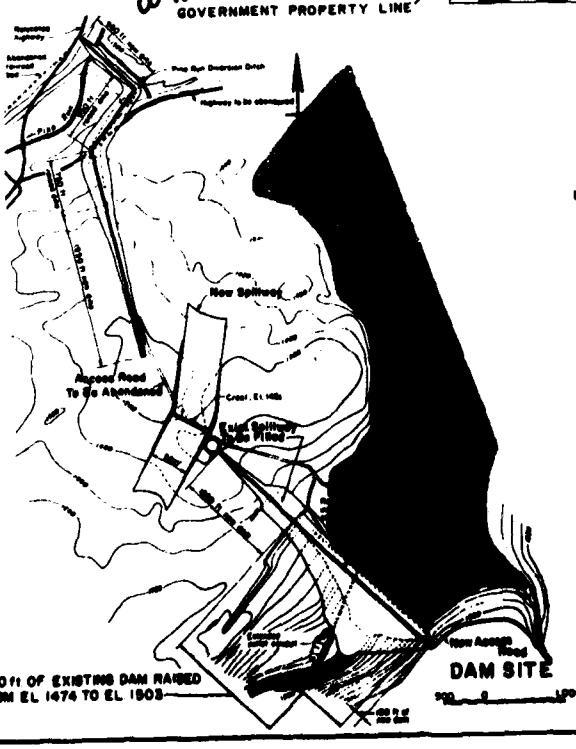


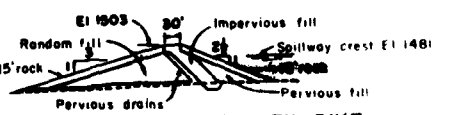
LOCATION MAP

SCALE

5 0 10 20 MILES







SECTION - PROPOSED NEW DIKE

100 0 100 200 FEET

LEHIGH RIVER, PA.

FLOOD CONTROL PROJECT

FRANCIS E. WALTER DAM

RESERVOIR AREA

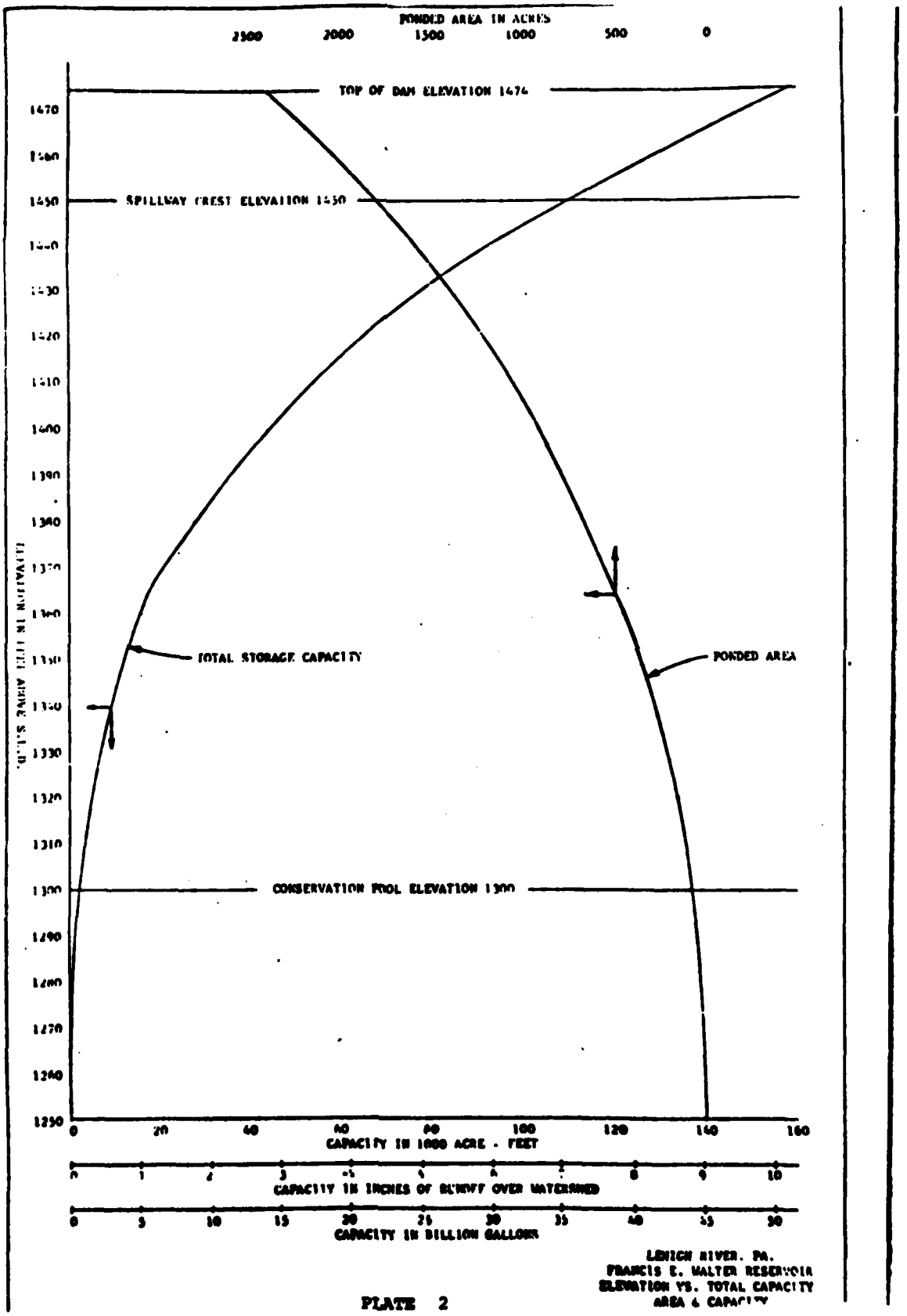
PLAN AND SECTION

REVISED 30 SEPTEMBER 1979

SCALES AS SHOWN

U S. ARMY ENGINEER DISTRICT, PHILA

PLATE 1



LEHIGH RIVER, PA.
FRANCIS E. WALTER RESERVOIR
ELEVATION VS. TOTAL CAPACITY
AREA & CAPACITY

PLATE 2

PLATE 3

POOL ELEVATION DRAWDOWN
(NAPEN-E Files)

TABLES

TABLE 1

CLIMATOLOGICAL DATA 1/ - Oct 1980 - Sept 1981

MONTH	Precp. (inches)	Total Snow (inches)	Avg. Temp. (oF)	Highest Temp. (oF)	Lowest Temp. (oF)	Days with Precp.
October data not available						
NOV.	3.19	7.0	34.3	62	10	10
DEC.	1.14	8.0	23.0	61	14	4
JAN.	.76	11.0	13.8	44	26	3
FEB.	7.47	11.0	28.9	62	-3	16
MAR.	.72	9.0	31.4	71	4	4
APRIL	3.41	0	46.6	72	17	12
MAY	4.03	0	55.6	84	24	9
JUNE	5.56	0	63.8	89	39	16

Data for July-Sept not available at time of report preparation.

END

DATE
FILMED

2-82

DTIC